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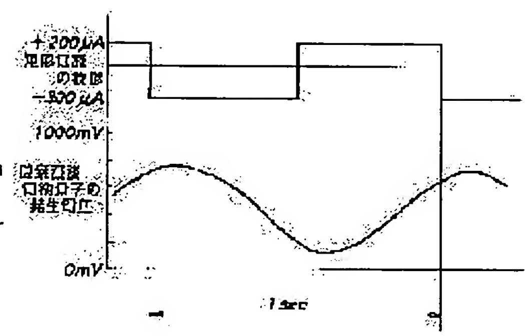
(54) METHOD FOR DETECTING AIR/FUEL RATIO

(57)Abstract:
PURPOSE: To enable a detection accuracy and a responsiveness to be improved simultaneously in a method for detecting an air/fuel ratio using an air/fuel ratio sensor which is equipped with an oxygen pump element and an oxygen light an darkness battery element.
CONSTITUTION: An air/fuel ratio sensor which is provided with an oxygen pump element which supplies oxygen to a measurement gas chamber and unloads oxygen from it and an oxygen light and darkness battery element which generates a voltage corresponding to oxygen concentration of the measurement gas chamber is used and a rectangular current with two types of alternate currents, namely a current of 200μA in positive direction for unloading oxygen from the measurement gas chamber and a current which has a larger absolute value than it which is 300μA in negative direction for supplying oxygen to the measurement gas chamber, is supplied to the above oxygen pump element. A duty ratio of the rectangular current is adjusted so that a generation voltage of an oxygen light and darkness battery element reaches a specified value and the air/fuel ratio is detected based on the duty ratio after adjustment. A veneration voltage of the oxygen light and darkness battery becomes a waveform which is symmetrical left and right and response can be improved by increasing frequency of the rectangular current.



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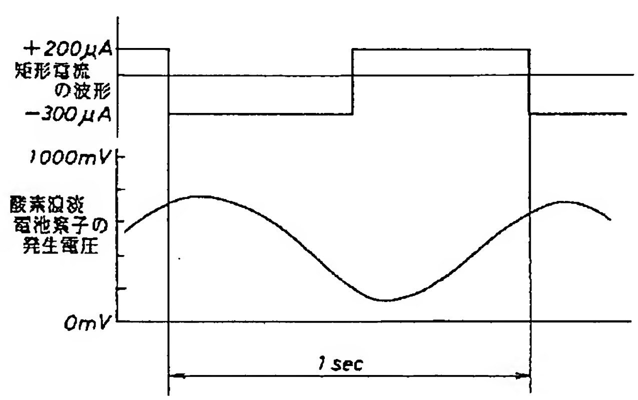
(54)【発明の名称】　空燃比検出方法

(57)【要約】

【目的】　酸素ポンプ素子および酸素濃淡電池素子を備えた空燃比センサを用いて空燃比を検出する方法において、検出精度および応答性を共に向上させる。

【構成】　酸素を測定ガス室に給排する酸素ポンプ素子と該測定ガス室の酸素濃度に対応した電圧を発生する酸素濃淡電池素子とを備えた空燃比センサを用い、上記測定ガス室から酸素を排出する正方向の電流（＋２００μＡ）と、それより大きな絶対値を有し上記測定ガス室へ酸素を供給する負方向の電流（－３００μＡ）との、二種類の電流が交番する矩形電流を上記酸素ポンプ素子に通電し、上記酸素濃淡電池素子の発生電圧が所定値となるように該矩形電流のデューティ比を調節し、調節後のデューティ比に基づいて空燃比を検出する。酸素濃淡電池の発生電圧が左右対称の波形となり、矩形電流の周波数を高くして応答性を向上させることができる。



【特許請求の範囲】

【請求項１】　ガス拡散制限部を介して測定ガス雰囲気と連通する測定ガス室と、通電される電気量に対応した量の酸素を該測定ガス室に給排する酸素ポンプ素子と、該測定ガス室の酸素濃度と基準となる酸素濃度との比に対応した電圧を発生する酸素濃淡電池素子と、を備えた空燃比センサを用いて空燃比を検出する空燃比検出方法において、上記測定ガス室から酸素を排出する正方向の電流値と、該電流値より大きな絶対値を有しかつ上記測定ガス室へ酸素を供給する負方向の電流値との、二種類の電流値が交番する矩形電流を上記酸素ポンプ素子に通電し、上記酸素濃淡電池素子の発生電圧が所定値となるように該矩形電流のデューティ比を調節し、上記矩形電流の調節後のデューティ比に基づいて空燃比を検出することを特徴とする空燃比検出方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、内燃機関等の各種燃焼機器において、排気中の酸素濃度に対応した信号を発生する酸素センサを用いて空燃比を検出する空燃比検出方法に関する。

【０００２】

【従来の技術】従来より内燃機関等の空燃比を検出する方法として、通電される電気量に対応した量の酸素を測定ガス室に給排する酸素ポンプ素子と、測定ガス室の酸素濃度と基準となる酸素濃度（例えば大気中の酸素濃度）との比に対応した電圧を発生する酸素濃淡電池素子と、を備えた空燃比センサを用いる方法が知られている。この方法は酸素濃淡電池素子の発生電圧が所定値となるように酸素ポンプ素子への通電電流を調節し、調節後の電流値に基づいて空燃比を検出するものである。

【０００３】例えばガソリンエンジンの排気管内に設置されるジルコニアを主体とした固体電解質を用いた酸素濃淡電池素子には、エンジンが理論空燃比で駆動されているとき所定値の電圧を発生するものがある。この種の酸素濃淡電池素子を備えた空燃比センサでは、酸素濃淡電池素子の発生電圧がその所定値となるように酸素ポンプ素子への通電電流を調節し、このときの通電電流が測定ガス室へ酸素を供給する負方向であるか、測定ガス室から酸素を排出する正方向であるかによって空燃比がリッチであるかリーンであるかを、その通電電流の大きさによってリッチ若しくはリーンである度合を知ることができる。

【０００４】

【発明が解決しようとする課題】ところがこのように酸素ポンプ素子に通電する電流の電流値に基づいて空燃比を検出する場合、電流値として得られた値に複雑な変換を施して空燃比を算出する必要があり、装置の構成が複雑になると共に検出精度の向上に限界があった。

【０００５】そこで酸素ポンプ素子への通電電流を、負方向と正方向との、予め設定された二種類の電流値が交番する矩形電流とし、酸素濃淡電池素子の発生電圧が所定値となるようにその矩形電流のデューティ比を調節し、そのデューティ比に基づいて空燃比を検出する方法が考えられる。この場合、矩形電流のデューティ比から空燃比を算出する処理はワンチップマイクロコンピュータを用いてソフトウェアで行うことができ、検出装置の構成を簡単にすると共に検出精度を向上させることができる。

【０００６】図４は、理論空燃比で駆動されているガソリンエンジンの排気管に空燃比センサを設置し、＋２００μＡおよび－２００μＡの電流値が、周波数１Ｈｚ，デューティ比０．５で交番する矩形電流を、酸素ポンプ素子に通電した場合の、矩形電流の波形および酸素濃淡電池素子の発生電圧をそれぞれ表している。尚、図において矩形電流の電流値は正方向を＋として描いている。また酸素濃淡電池素子はガソリンエンジンが理論空燃比で駆動されているとき、その排気管内の酸素濃度に対して４５０ｍＶの電圧を発生するものである。

【０００７】図に示すように矩形電流が－２００μＡとなり酸素が測定ガス室へ供給されると、測定ガス室内の酸素濃度が上昇して基準酸素濃度との差が少なくなるため、酸素濃淡電池素子の発生電圧が低下する。続いて矩形電流が＋２００μＡとなり酸素が測定ガス室から排出されると、測定ガス室内の酸素濃度が低下して基準酸素濃度との差が拡大するため、酸素濃淡電池素子の発生電圧が上昇する。そして再び矩形電流が－２００μＡとなって酸素濃淡電池素子の発生電圧が低下するといった挙動が周期的に繰り返され、酸素濃淡電池素子の発生電圧は理論空燃比近傍における起電力を発生し、数百ｍＶの幅で振動するようになる。

【０００８】ところがこの場合、以下に述べる理由により酸素濃淡電池素子の発生電圧の変化は下降するときよりも上昇するときの方が急峻となる。即ち、炭化水素，水素，ＣＯ等の未燃ガスは分子量が小さくガス拡散制限部を介して測定ガス室内に侵入し易い。このため負方向の電流によって測定ガス室内に供給された酸素は、一部がこれら未燃ガスとの酸化反応によって消費されるので、酸素濃淡電池による発生電圧の降下が鈍化するのである。

【０００９】一方デューティ比に基づいて空燃比を検出する場合、検出結果は矩形電流の一周期毎にしか得られないので、検出の応答性を向上させるためには周波数を高くする必要がある。ところが、このように酸素濃淡電池素子の電圧波形が非対称である場合、周波数を所定値以上に高くすると酸素濃淡電池素子の発生電圧は電圧が高い方向へ大きくずれてしまうことがあった。

【００１０】図５に、矩形電流の周波数を４０Ｈｚとした点を除いてはすべて図４と同様の条件で測定した矩形電流の波形および酸素濃淡電池素子の発生電圧を例示す

る。この場合、酸素濃淡電池素子の発生電圧は６００ｍＶ近傍を小刻みに振動する。これは矩形電流の周波数があまり高いと正方向の電流によって測定ガス室から排出されるだけの酸素量を負方向電流によって供給しきれず、測定ガス室内の酸素濃度が排気管内の酸素濃度よりも低くなってしまうためと考えられ、この結果ガソリンエンジンの空燃比があたかもリッチであるかのような検出結果が得られるのである。このため、酸素ポンプ素子の通電電流のデューティ比に基づいて空燃比を検出する方法では検出の応答性を向上させることが困難であった。

【００１１】そこで本発明は、酸素ポンプ素子および酸素濃淡電池素子を備えた空燃比センサを用いて空燃比を検出する方法において、検出精度および応答性を共に向上させることを目的としてなされた。

【００１２】

【課題を解決するための手段】上記目的を達するためになされた本発明は、ガス拡散制限部を介して測定ガス雰囲気と連通する測定ガス室と、通電される電気量に対応した量の酸素を該測定ガス室に給排する酸素ポンプ素子と、該測定ガス室の酸素濃度と基準となる酸素濃度との比に対応した電圧を発生する酸素濃淡電池素子と、を備えた空燃比センサを用いて空燃比を検出する空燃比検出方法において、上記測定ガス室から酸素を排出する正方向の電流値と、該電流値より大きな絶対値を有しかつ上記測定ガス室へ酸素を供給する負方向の電流値との、二種類の電流値が交番する矩形電流を上記酸素ポンプ素子に通電し、上記酸素濃淡電池素子の発生電圧が所定値となるように該矩形電流のデューティ比を調節し、上記矩形電流の調節後のデューティ比に基づいて空燃比を検出することを特徴とする空燃比検出方法、を要旨としている。

【００１３】

【作用】このように構成された本発明の空燃比検出方法では、酸素濃淡電池素子の発生電圧が所定値となるように酸素ポンプ素子に供給する矩形電流のデューティ比を調節し、そのデューティ比に基づいて空燃比を検出している。矩形電流のデューティ比から空燃比を算出する処理はワンチップマイクロコンピュータを用いてソフトウエアで行うことができるので、検出装置の構成を簡単にすると共に検出精度を向上させることができる。

【００１４】また矩形電流を構成する負方向の電流値の方が、正方向の電流値より絶対値において大きいので、酸素濃淡電池素子の発生電圧は上昇するときと低下するときとの変化速度を略同じすることができる。このため矩形電流の周波数を高くしたときに酸素濃淡電池素子の発生電圧が高くなるのを防止することができる。

【００１５】

【実施例】以下本発明の実施例を図面と共に説明する。図１は本発明が適用される実施例の空燃比検出装置を表す概略構成図である。先ず空燃比センサ１は、固体電解質基板３ａの両側に多孔質電極３ｂ，３ｃを形成した酸素ポンプ素子３と、同じく固体電解質基板５ａの両側に多孔質電極５ｂ，５ｃを形成した酸素濃淡電池素子５と、これらの両素子３，５の間に積層されて測定ガス室７を形成するスペーサ９とを備えている。そして、この空燃比センサ１は図示せぬ内燃機関の排気系に取り付けられる。

【００１６】ここで、固体電解質基板３ａ，５ａはイットリアージルコニア固溶体から形成され、多孔質電極３ｂ，３ｃ，５ｂ，５ｃは、共素地としてのイットリアージルコニア固溶体と残部白金から形成されている。尚、上記固体電解質基板３ａ，５ａの材料としては、イットリアージルコニア固溶体の他に、カルシアージルコニア固溶体が知られており、更に、二酸化セリウム、二酸化トリウム、二酸化ハフニウムの各固溶体、ペロブスカイト型固溶体、３価金属酸化物固溶体等が使用できる。

【００１７】また、酸素濃淡電池素子５の外側の多孔質電極５ｃを覆って、固体電解質からなる遮蔽体１１が貼り付けられている。一方スペーサ９の素材としては、アルミナ、スピネル、フォルステライト、ステアタイト、ジルコニア等が用いられる。また、測定ガス室７の内側には、上記多孔質電極３ｃ，５ｂが露出しており、更に、スペーサ９の先端には、測定ガス室７と排気管内の測定ガス雰囲気とを連通させるガス拡散孔１３が設けられている。このガス拡散孔１３には、アルミナからなる多孔質の充填材１５が詰められており、それによって、測定ガスの測定ガス室７への流入等を律速するガス拡散制限部１７が形成される。

【００１８】次に酸素ポンプ素子３の多孔質電極３ｂ，３ｃの間には、リレー１９の接点Ｒ１を介して直流電源２１が接続されると共に、それと並列にリレー１９の接点Ｒ２を介して直流電源２３が接続されている。尚、接点Ｒ１は通常閉じておりリレー１９のソレノイドコイルＬが励磁されると開く所謂ｂ接点であり、一方接点Ｒ２は通常開いておりソレノイドコイルＬが励磁されると閉じる所謂ａ接点である。またソレノイドコイルＬには駆動回路等を備えた電子制御回路ＥＣＵからの信号が入力され、これによってリレー１９が駆動される。

【００１９】尚、直流電源２３は多孔質電極３ｂから多孔質電極３ｃに向かって２００μＡの電流を供給し、直流電源２１は多孔質電極３ｃから多孔質電極３ｂに向かって３００μＡの電流を供給するものである。一方多孔質電極５ｂ，５ｃの間には、多孔質電極５ｃから多孔質電極５ｂに向かって常時２７．５μＡの電流を供給する直流電源２５が接続され、更に多孔質電極５ｂ，５ｃ間に発生する電圧は電子制御回路ＥＣＵに入力されている。

【００２０】次にこのように構成された空燃比検出装置の動作を説明する。先ず直流電源２５が多孔質電極５ｃ

から多孔質電極５ｂに向かって常時２７．５μＡの電流を供給すると、測定ガス室７内の酸素ガスが多孔質電極５ｂ表面でイオン化した後固体電解質基板５ａを介して多孔質電極５ｃ表面へ移動し、そこで再び酸素ガスとなる。多孔質電極５ｃは遮蔽体１１によって被覆され所定の漏出抵抗を有するので、多孔質電極５ｃ表面は基準となる酸素濃度、例えば大気と同程度、若しくはそれ以上の酸素濃度に保持される。尚酸素濃淡電池素子に定常電流を通電して、基準となる酸素濃度を得る方法は、特開昭６１－２９６２６２号に詳しいのでここでは詳述しない。

【００２１】次に電子制御回路ＥＣＵは設定された周波数でソレノイドコイルＬに矩形パルス状の電流を通電する。ソレノイドコイルＬにパルス状の電流が通電されると接点Ｒ２が閉じ、直流電源２３によって多孔質電極３ｂから多孔質電極３ｃに向かって２００μＡの電流が供給される。すると測定ガス室７内の酸素ガスは多孔質電極３ｃ表面でイオン化した後固体電解質基板３ａを介して多孔質電極３ｂ表面へ移動し、再び酸素ガスとして測定ガス雰囲気に排出される。

【００２２】一方ソレノイドコイルＬに通電されていたパルス状の電流が立ち下がると、接点Ｒ１が閉じ、直流電源２１によって多孔質電極３ｃから多孔質電極３ｂに向かって３００μＡの電流が供給される。すると測定ガス雰囲気の酸素ガスは多孔質電極３ｂ表面でイオン化した後固体電解質基板３ａを介して測定ガス室７内へ供給される。即ち酸素ポンプ素子３は、正方向の２００μＡと負方向の３００μＡとの二種類の電流値が、ソレノイドコイルＬに通電される矩形パルスと同一のデューティ比で交番する矩形電流を通電される。

【００２３】このように酸素ガスが給排されて測定ガス室７内の酸素濃度が変化すると、それに伴って多孔質電極５ｂ表面の酸素濃度も変化する。一方酸素濃淡電池素子５は多孔質電極５ｂ表面と多孔質電極５ｃ表面との酸素濃度比に対応した電圧を発生し、これによって両電極５ｂ，５ｃ間の電位差が変化する。電子制御回路ＥＣＵは多孔質電極５ｂ，５ｃ間の発生電圧を入力され、この電圧が所定の値となるようにソレノイドコイルＬに通電するパルス状電流のデューティ比を調整する。更に電子制御回路ＥＣＵはそのパルス状電流の調整後のデューティ比に基づいて内燃機関の空燃比を検出し、検出結果を図示しない空燃比制御系へ出力する。

【００２４】図２は理論空燃比で駆動されているガソリンエンジンの排気管に空燃比センサ１を設置し、酸素ポンプ素子３に通電される矩形電流を、周波数が１Ｈｚ，デューティ比０．５としたときの、酸素ポンプ素子３に供給される矩形電流の波形及び酸素濃淡電池素子５の発生電圧を表している。尚、図において矩形波電流の電流値は正方向を＋として描いている。また酸素濃淡電池素子５はガソリンエンジンが理論空燃比で駆動されているとき、その排気管内の酸素濃度に対して４５０ｍＶの電圧を発生するものである。

【００２５】図に示すように矩形電流が－３００μＡとなり酸素が測定ガス室７へ供給されると、測定ガス室７内の酸素濃度が上昇して多孔質電極５ｂ表面と多孔質電極５ｃ表面との酸素濃度の差が少なくなるため、酸素濃淡電池素子５の発生電圧が低下する。続いて矩形電流が＋２００μＡとなり酸素が測定ガス室７から排出されると、測定ガス室７内の酸素濃度が低下して、多孔質電極５ｂ表面と多孔質電極５ｃ表面との酸素濃度の差が拡大するため、酸素濃淡電池素子５の発生電圧が上昇する。そして再び矩形電流が－３００μＡとなって酸素濃淡電池素子５の発生電圧が低下するといった挙動が周期的に繰り返され、酸素濃淡電池素子５の発生電圧は４５０ｍＶを中心に振動するようになる。

【００２６】これは、矩形電流のデューティ比を０．５とすれば測定ガス室７の酸素濃度の平均値と排気管内の酸素濃度とが等しくなるためである。また、本実施例では正方向電流の絶対値を負方向電流の絶対値の１．５倍にしているので、酸素濃淡電池素子５の発生電圧は、上昇するときと低下するときとの変化速度が略同じとなり略左右対称の曲線を呈する。

【００２７】このため矩形電流の周波数を高くしても、デューティ比が０．５であれば測定ガス室７内の酸素濃度の平均値と排気管内の酸素濃度とを一致させることができる。図３に、矩形電流の周波数を４０Ｈｚとした点を除いてはすべて図２と同様の条件で測定した矩形電流の波形および酸素濃淡電池素子５の発生電圧を示す。この場合、酸素濃淡電池素子５の発生電圧の変化は小刻みになるが、相変わらず４５０ｍＶを中心に振動する。即ち測定ガス室７の酸素濃度の平均値と排気管内の酸素濃度とが一致していることが判る。

【００２８】このように、本実施例では酸素ポンプ素子３に通電する矩形電流の周波数を高くしても、理論空燃比で駆動しているガソリンエンジンに対して、矩形電流のデューティ比０．５と酸素濃淡電池素子５の発生電圧４５０ｍＶとを対応させることができる。

【００２９】このため、例えば酸素濃淡電池素子５の発生電圧を４５０ｍＶとするために酸素ポンプ素子３に通電する矩形電流のデューティ比を０．５より小さくしなければならない場合、即ち測定ガス室７に酸素を供給する負方向の電流を正方向の電流より長く通電しなければならない場合は、ガソリンエンジンの空燃比がリッチであり、逆に、酸素濃淡電池素子５の発生電圧を４５０ｍＶとするために酸素ポンプ素子３に通電する矩形電流のデューティ比を０．５より大きくしなければならない場合、即ち測定ガス室７から酸素を排出する正方向の電流を負方向の電流より長く通電しなければならない場合は、ガソリンエンジンの空燃比がリーンであると判断することができる。また、このような空燃比の検出は矩形

電流の周波数が高くても同様に行なうことができる。

【００３０】また更に、矩形電流のデューティ比から空燃比を算出する処理はワンチップマイクロコンピュータを用いてソフトウェアで行うことができ、検出装置の構成を簡単にすると共に検出精度を向上させることができる。このように本実施例の空燃比検出装置では、内燃機関の空燃比を酸素ポンプ素子３に通電する矩形電流のデューティ比に基づいて検出することにより、検出装置の構成を簡単にすると共に検出精度を向上させることができ、更にその矩形電流の周波数を高くすることにより応答性を向上させることができる。

【００３１】尚、本実施例では酸素ポンプ素子３に通電する矩形電流を＋２００μＡと－３００μＡとの二種類の電流値で構成しているが、この電流値は空燃比センサの特性や検出しようとする空燃比に応じて適切な値に設定することができる。

【００３２】

【発明の効果】以上詳述したように本発明の空燃比検出方法では、酸素ポンプ素子に通電する矩形電流のデューティ比に基づいて空燃比を検出しているので、検出装置の構成を簡単にすると共に検出精度を向上させることができる。

【００３３】また、酸素ポンプ素子に通電する矩形電流の周波数を高くしても酸素濃淡電池素子の発生電圧が高くならないので、矩形波の周波数を高くして検出の応答性を向上させることができる。

【図面の簡単な説明】

【図１】実施例の空燃比検出装置を表す概略構成図である。

【図２】実施例の酸素ポンプ素子に供給される低周波数の矩形電流の波形および酸素濃淡電池素子の発生電圧を表す説明図である。

【図３】実施例の酸素ポンプ素子に供給される高周波数の矩形電流の波形および酸素濃淡電池素子の発生電圧を表す説明図である。

【図４】従来例の酸素ポンプ素子に供給される低周波数の矩形電流の波形および酸素濃淡電池素子の発生電圧を表す説明図である。

【図５】従来例の酸素ポンプ素子に供給される高周波数の矩形電流の波形および酸素濃淡電池素子の発生電圧を表す説明図である。

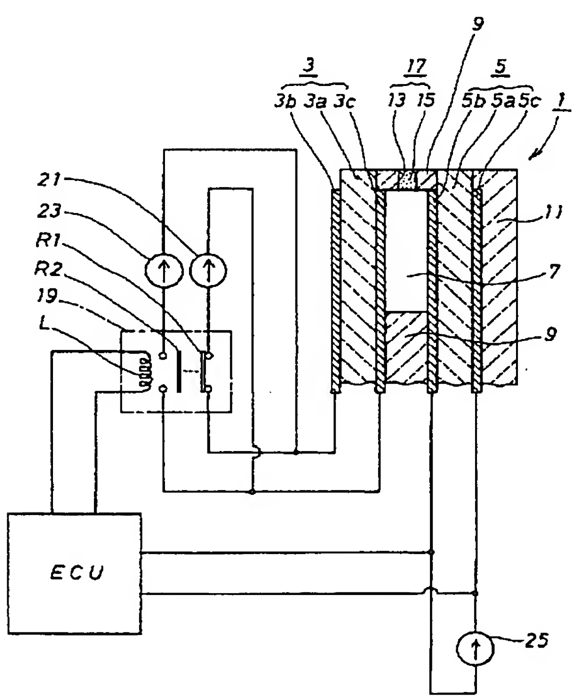
【符号の説明】

１…空燃比センサ　　３…酸素ポンプ素子　　５…酸素濃淡電池素子

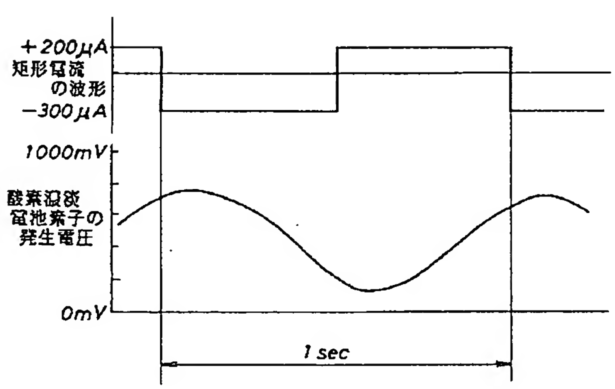
７…測定ガス室　　１７…ガス拡散制限部　　１９…リレー

２１，２３，２５…直流電源

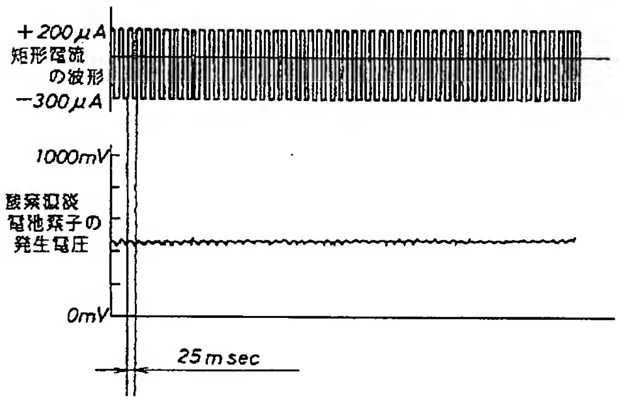
【図１】



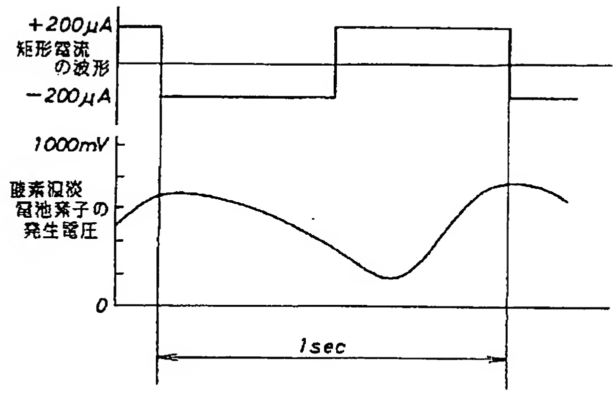
【図２】



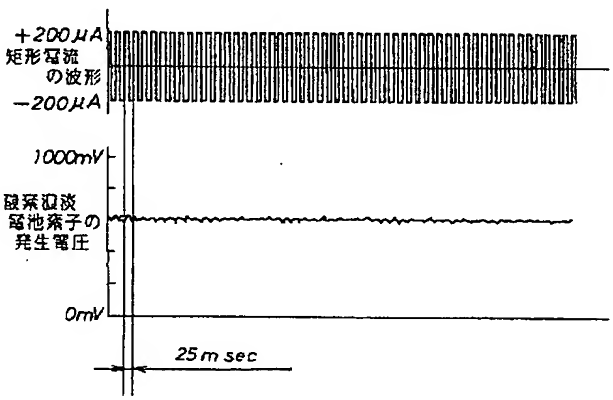
【図３】


+200μA
矩形電流
の波形
−300μA
1000mV
酸素濃淡
電池素子の
発生電圧
0mV
25m sec

【図４】


+200μA
矩形電流
の波形
−200μA
1000mV
酸素濃淡
電池素子の
発生電圧
0
1sec

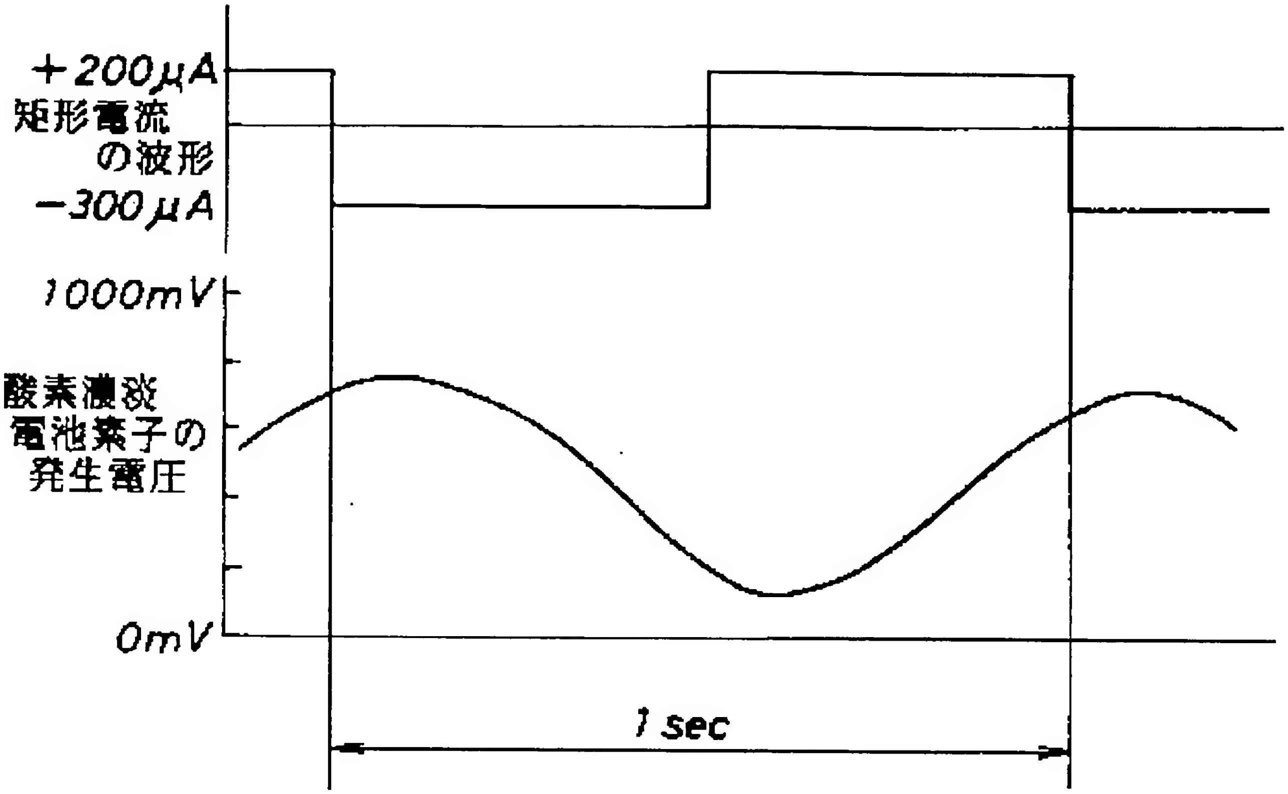
【図５】


+200μA
矩形電流
の波形
−200μA
1000mV
酸素濃淡
電池素子の
発生電圧
0mV
25m sec

CLAIMS

[Claim(s)]
[Claim 1] The oxygen-pumping component which carries out the feeding and discarding of the oxygen of a measurement gas ambient atmosphere, a measurement gas chamber open for free passage, and the amount corresponding to quantity of electricity to energize to this measurement gas chamber through the gaseous diffusion limit section, In the air-fuel ratio detection approach of detecting an air-fuel ratio using the air-fuel ratio sensor equipped with the oxygen-concentration-cell component which generates the electrical potential difference corresponding to a ratio with the oxygen density used as the oxygen density of this measurement gas chamber, and criteria The current value of the negative direction which has the current value of the forward direction which discharges oxygen from the above-mentioned measurement gas chamber, and a bigger absolute value than this current value, and supplies oxygen to the above-mentioned measurement gas chamber, The air-fuel ratio detection approach characterized by energizing the rectangle current in which two kinds of current values carry out alternation for the above-mentioned oxygen-pumping component, adjusting the duty ratio of this rectangle current so that the generated voltage of the above-mentioned oxygen-concentration-cell component may serve as a predetermined value, and detecting an air-fuel ratio based on the duty ratio after accommodation of the above-mentioned rectangle current.

[Translation done.]


+200μA
矩形電流の波形
−300μA
1000mV
酸素濃淡電池素子の発生電圧
0mV
1 sec

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the air-fuel ratio detection approach of detecting an air-fuel ratio using the oxygen sensor which generates the signal corresponding to the oxygen density under exhaust air, in various burning appliances, such as an internal combustion engine.
[0002]
[Description of the Prior Art] The approach using the air-fuel ratio sensor equipped with the oxygen-concentration-cell component which generates the electrical potential difference corresponding to the ratio of the oxygen-pumping component which carries out the feeding and discarding of the oxygen of the amount corresponding to quantity of electricity to energize to a measurement gas chamber as an approach of detecting an internal combustion engine's etc. air-fuel ratio conventionally, and the oxygen density (for example, oxygen density in atmospheric air) used as the oxygen density of a measurement gas chamber and criteria is learned. This approach adjusts the energization current to an oxygen-pumping component so that the generated voltage of an oxygen-concentration-cell component may serve as a predetermined value, and it detects an air-fuel ratio based on the current value after accommodation.
[0003] For example, while the engine is driving by theoretical air fuel ratio, there are some which generate the electrical potential difference of a predetermined value in the oxygen-concentration-cell component using the solid electrolyte which made the subject the zirconia installed in the exhaust pipe of a gasoline engine. By the air-fuel ratio sensor equipped with this kind of oxygen-concentration-cell component, the energization current to an oxygen-pumping component can be adjusted so that the generated voltage of an oxygen-concentration-cell component may serve as that predetermined value, and rich or the degree which is Lean can be known for whether whether it is the negative direction where the energization current at this time supplies oxygen to a measurement gas chamber or it being the forward direction which discharges oxygen from a measurement gas chamber, and an air-fuel ratio are rich, or you are Lean with the magnitude of that energization current.
[0004]
[Problem(s) to be Solved by the Invention] However, when an air-fuel ratio was detected based on the current value of the current energized for an oxygen-pumping component in this way, the air-fuel ratio needed to be computed by having performed complicated conversion to the value acquired as a current value, and while the configuration of equipment became complicated, the limitation was in improvement in detection precision.
[0005] Then, the energization current to an oxygen-pumping component is made into the rectangle current in which two kinds of current values of the negative direction and the forward direction set up beforehand carry out alternation, the duty ratio of the rectangle current is adjusted so that the generated voltage of an oxygen-concentration-cell component may serve as a predetermined value, and how to detect an air-fuel ratio based on the duty ratio can be considered. In this case, software can perform processing which computes an air-fuel ratio from the duty ratio of a rectangle current using an one-chip microcomputer, and detection precision can be raised while simplifying the configuration of detection equipment.
[0006] Drawing 4 installs an air-fuel ratio sensor in the exhaust pipe of the gasoline engine currently driven by theoretical air fuel ratio, and expresses the wave of a rectangle current when the current value of +200microA and -200microA energizes the rectangle current which carries out alternation with the frequency of 1Hz, and a duty ratio 0.5 for an oxygen-pumping component, and the generated voltage of an oxygen-concentration-cell component, respectively. In addition, in drawing, the current value of a rectangle current is drawing the forward direction as +. Moreover, an oxygen-concentration-cell component generates the electrical potential difference of 450mV to the oxygen density in the exhaust pipe, while the gasoline engine is driving by theoretical air fuel ratio.

[0007] If a rectangle current is set to -200microA and oxygen is supplied to a measurement gas chamber, as shown in drawing, since the oxygen density of the measurement gas interior of a room will go up and a difference with a criteria oxygen density will decrease, the generated voltage of an oxygen-concentration-cell component falls. Then, if a rectangle current is set to +200microA and oxygen is discharged from a measurement gas chamber, since the oxygen density of the measurement gas interior of a room will fall and a difference with a criteria oxygen density will be expanded, the generated voltage of an oxygen-concentration-cell component goes up. And a rectangle current is again set to -200microA, the behavior that the generated voltage of an oxygen-concentration-cell component falls is repeated periodically, and the generated voltage of an oxygen-concentration-cell component generates electromotive force [/ near the theoretical air fuel ratio], and comes to vibrate by width of face of hundreds of mV.
[0008] However, the direction when going up rather than the time of the generating change of potential of an oxygen-concentration-cell component descending for the reason explained below in this case becomes steep. That is, molecular weight is small and unburnt gases, such as a hydrocarbon, hydrogen, and CO, tend to trespass upon the measurement gas interior of a room through the gaseous diffusion limit section. For this reason, since a part is consumed by oxidation reaction with these unburnt gases, as for the oxygen supplied to the measurement gas interior of a room by the current of the negative direction, descent of the generated voltage by the oxygen concentration cell becomes slow.
[0009] Since a detection result is not obtained for every round term of a rectangle current on the other hand when detecting an air-fuel ratio based on a duty ratio, in order to raise the responsibility of detection, it is necessary to make a frequency high. However, when the voltage waveform of an oxygen-concentration-cell component was unsymmetrical in this way, and the frequency was made high beyond a predetermined value, the generated voltage of an oxygen-concentration-cell component might shift in the direction where an electrical potential difference is high greatly.
[0010] If the point which set the frequency of a rectangle current to 40Hz at drawing 5 is removed, the wave of the rectangle current altogether measured on the same conditions as drawing 4 and the generated voltage of an oxygen-concentration-cell component are illustrated. In this case, the generated voltage of an oxygen-concentration-cell component vibrates about 600mV gradually. If this has the not much high frequency of a rectangle current, the amount only of oxygen discharged by the current of the forward direction from a measurement gas chamber cannot be supplied according to the negative direction current, and it thinks because the oxygen density of the measurement gas interior of a room becomes low rather than the oxygen density in an exhaust pipe, and a detection result as if the air-fuel ratio of a gasoline engine was rich as a result is obtained. For this reason, it was difficult to raise the responsibility of detection by the approach of detecting an air-fuel ratio based on the duty ratio of the energization current of an oxygen-pumping component.
[0011] Then, this invention was made in the approach of detecting an air-fuel ratio using the air-fuel ratio sensor equipped with the oxygen-pumping component and the oxygen-concentration-cell component, for the purpose of raising both detection precision and responsibility.
[0012]
[Means for Solving the Problem] The measurement gas chamber which this invention made since the above-mentioned purpose was attained opens for free passage with a measurement gas ambient atmosphere through the gaseous diffusion limit section, The oxygen-pumping component which carries out the feeding and discarding of the oxygen of the amount corresponding to quantity of electricity to energize to this measurement gas chamber, In the air-fuel ratio detection approach of detecting an air-fuel ratio using the air-fuel ratio sensor equipped with the oxygen-concentration-cell component which generates the electrical potential difference corresponding to a ratio with the oxygen density used as the oxygen density of this measurement gas chamber, and criteria The current value of the negative direction which has the current value of the forward direction which discharges oxygen from the above-mentioned measurement gas chamber, and a bigger absolute value than this current value, and supplies oxygen to the above-mentioned measurement gas chamber, The rectangle current in which two kinds of current values carry out alternation is energized for the above-mentioned oxygen-pumping component. The duty ratio of this rectangle current is adjusted so that the generated voltage of the above-mentioned oxygen-concentration-cell component may serve as a predetermined value, and the air-fuel ratio detection approach characterized by detecting an air-fuel ratio based on the duty ratio after accommodation of the above-mentioned rectangle current is made into the summary.
[0013]
[Function] Thus, by the air-fuel ratio detection approach of constituted this invention, the duty ratio of the rectangle current supplied to an oxygen-pumping component was adjusted so that the generated voltage of an oxygen-concentration-cell component might serve as a predetermined value, and the air-fuel ratio is detected based on the duty ratio. Since software can perform processing which computes an air-fuel ratio using an one-chip microcomputer from the duty ratio of a rectangle current, detection precision can be raised while simplifying the configuration of detection

equipment.

[0014] moreover, a change rate with the time of the generated voltage of an oxygen-concentration-cell component falling with the time of going up, since the current value of the negative direction which constitutes a rectangle current is larger than the current value of the forward direction in an absolute value -- abbreviation -- the same -- it can carry out. For this reason, when the frequency of a rectangle current is made high, it can prevent that the generated voltage of an oxygen-concentration-cell component becomes high.

[0015]

[Example] The example of this invention is explained with a drawing below. Drawing 1 is an outline block diagram showing the air-fuel ratio detection equipment of an example with which this invention is applied. The air-fuel ratio sensor 1 is first equipped with the spacer 9 which a laminating is carried out and forms the measurement gas chamber 7 between the oxygen-pumping component 3 which formed porous electrodes 3b and 3c in the both sides of solid electrolyte substrate 3a, the oxygen-concentration-cell components 5 which similarly formed porous electrodes 5b and 5c in the both sides of solid electrolyte substrate 5a, and both these components 3 and 5. And this air-fuel ratio sensor 1 is attached in the exhaust air system of the internal combustion engine which does not illustrate.

[0016] Here, the solid electrolyte substrates 3a and 5a are formed from the yttria-zirconia solid solution, and porous electrodes 3b, 3c, 5b, and 5c are formed from the yttria-zirconia solid solution and remainder platinum as ******. In addition, as an ingredient of the above-mentioned solid electrolyte substrates 3a and 5a, the calcia-zirconia solid solution other than the yttria-zirconia solid solution is known, and each solid solution of a cerium dioxide, a thorium dioxide, and a diacid-ized hafnium, the perovskite mold solid solution, the trivalent metal oxide solid solution, etc. can be used further.

[0017] Moreover, porous electrode 5c of the outside of the oxygen-concentration-cell component 5 is covered, and the screen 11 which consists of a solid electrolyte is stuck. On the other hand as a material of a spacer 9, an alumina, a spinel, forsterite, a steatite, a zirconia, etc. are used. Moreover, inside the measurement gas chamber 7, the above-mentioned porous electrodes 3c and 5b are exposed, and the gaseous diffusion hole 13 which makes the measurement gas chamber 7 and the measurement gas ambient atmosphere in an exhaust pipe open for free passage is further formed at the tip of a spacer 9. The filler 15 of the porosity which consists of an alumina is put in this gaseous diffusion hole 13, and the gaseous diffusion limit section 17 which carries out rate-limiting [of the inflow in the measurement gas chamber 7 of measurement gas etc.] by it is formed.

[0018] Next, while DC power supply 21 are connected through the contact R1 of relay 19 among the porous electrodes 3b and 3c of the oxygen-pumping component 3, DC power supply 23 are connected to it and juxtaposition through the contact R2 of relay 19. In addition, a contact R1 is the so-called b contact which will be opened if it has usually closed and the solenoid coil L of relay 19 is excited, and, on the other hand, is the so-called a-contact which will be closed if the contact R2 is usually opened and a solenoid coil L is excited. Moreover, the signal from the electronic control circuit ECU equipped with the drive circuit etc. is inputted into a solenoid coil L, and relay 19 drives by this.

[0019] In addition, DC power supply 23 supply the current of 200microA toward porous electrode 3b to porous electrode 3c, and DC power supply 21 supply the current of 300microA toward porous electrode 3b from porous electrode 3c. On the other hand among porous electrodes 5b and 5c, DC power supply 25 which always supply the current of 27.5microA toward porous electrode 5b from porous electrode 5c are connected, and the electrical potential difference further generated between porous electrode 5b and 5c is inputted into the electronic control circuit ECU.

[0020] Next, actuation of the air-fuel ratio detection equipment constituted in this way is explained. If DC power supply 25 always supply the current of 27.5microA toward porous electrode 5b from porous electrode 5c first, after the oxygen gas in the measurement gas chamber 7 ionizes on a porous electrode 5b front face, it will move to a porous electrode 5c front face through solid electrolyte substrate 5a, and will become oxygen gas again there. Since porous electrode 5c is covered with a screen 11 and has predetermined exsorption resistance, a porous electrode 5c front face is held at the oxygen density used as criteria, for example, comparable [atmospheric air and comparable], and the oxygen density beyond it. In addition, since it is detailed to JP,61-296262,A, the approach of obtaining the oxygen density which energizes the stationary current for an oxygen-concentration-cell component, and serves as criteria is not explained in full detail here.

[0021] Next, an electronic control circuit ECU energizes a rectangular pulse-like current to a solenoid coil L on the set-up frequency. If a pulse-like current energizes to a solenoid coil L, a contact R2 will close and the current of 200microA will be supplied by DC power supply 23 toward porous electrode 3c from porous electrode 3b. Then, after ionizing the oxygen gas in the measurement gas chamber 7 on a porous electrode 3c front face, it moves to a porous electrode 3b front face through solid electrolyte substrate 3a, and it is again discharged by the measurement gas ambient atmosphere as oxygen gas.

[0022] If the current of the shape of a pulse which was being energized to the solenoid coil L on the other hand falls, a contact R1 will close and the current of 300microA will be supplied by DC power supply 21 toward porous electrode 3b from porous electrode 3c. Then, after ionizing the oxygen gas of a measurement gas ambient atmosphere on a porous electrode 3b front face, it is supplied into the measurement gas chamber 7 through solid electrolyte substrate 3a. That is, the oxygen-pumping component 3 energizes the rectangle current which carries out alternation with the duty ratio as the rectangular pulse energized to a solenoid coil L with two kinds of same current values of 200microA of the forward direction, and 300microA of the negative direction.
[0023] Thus, if the feeding and discarding of the oxygen gas are carried out and the oxygen density in the measurement gas chamber 7 changes, in connection with it, the oxygen density of a porous electrode 5b front face will also change. On the other hand, the oxygen-concentration-cell component 5 generates the electrical potential difference corresponding to the oxygen ratio of concentration of a porous electrode 5b front face and a porous electrode 5c front face, and the potential difference between two-electrodes 5b and 5c changes with these. The generated voltage between porous electrode 5b and 5c is inputted into an electronic control circuit ECU, and it adjusts the duty ratio of the pulse-like current energized to a solenoid coil L so that this electrical potential difference may serve as a predetermined value. Furthermore, an electronic control circuit ECU detects an internal combustion engine's air-fuel ratio based on the duty ratio after adjustment of the pulse-like current, and outputs it to the Air Fuel Ratio Control system which does not illustrate a detection result.
[0024] Drawing 2 installs the air-fuel ratio sensor 1 in the exhaust pipe of the gasoline engine currently driven by theoretical air fuel ratio, and expresses the wave of the rectangle current supplied to the oxygen-pumping component 3 when a frequency makes the rectangle current energized for the oxygen-pumping component 3 1Hz and a duty ratio 0.5, and the generated voltage of the oxygen-concentration-cell component 5. In addition, in drawing, the current value of rectangular current is drawing the forward direction as +. Moreover, the oxygen-concentration-cell component 5 generates the electrical potential difference of 450mV to the oxygen density in the exhaust pipe, while the gasoline engine is driving by theoretical air fuel ratio.
[0025] If a rectangle current is set to -300microA and oxygen is supplied to the measurement gas chamber 7, as shown in drawing, since the oxygen density in the measurement gas chamber 7 will go up and the difference of the oxygen density of a porous electrode 5b front face and a porous electrode 5c front face will decrease, the generated voltage of the oxygen-concentration-cell component 5 falls. Then, if a rectangle current is set to +200microA and oxygen is discharged from the measurement gas chamber 7, since the oxygen density in the measurement gas chamber 7 will fall and the difference of the oxygen density of a porous electrode 5b front face and a porous electrode 5c front face will be expanded, the generated voltage of the oxygen-concentration-cell component 5 goes up. And a rectangle current is again set to -300microA, the behavior that the generated voltage of the oxygen-concentration-cell component 5 falls is repeated periodically, and the generated voltage of the oxygen-concentration-cell component 5 comes to vibrate focusing on 450mV.
[0026] This is because the average of the oxygen density of 0.5, then the measurement gas chamber 7 and the oxygen density in an exhaust pipe become equal about the duty ratio of a rectangle current. moreover, a change rate with the time of the generated voltage of the oxygen-concentration-cell component 5 falling with the time of going up, since the absolute value of the forward direction current is increased 1.5 times of the absolute value of the negative direction current in this example -- abbreviation -- it becomes the same and the curve of abbreviation bilateral symmetry is presented.
[0027] For this reason, even if it makes the frequency of a rectangle current high, if a duty ratio is 0.5, the average of the oxygen density in the measurement gas chamber 7 and the oxygen density in an exhaust pipe can be made in agreement. If the point which set the frequency of a rectangle current to 40Hz at drawing 3 is removed, the wave of the rectangle current altogether measured on the same conditions as drawing 2 and the generated voltage of the oxygen-concentration-cell component 5 are shown. In this case, although the generating change of potential of the oxygen-concentration-cell component 5 becomes gradual, it vibrates focusing on 450mV as usual. That is, it turns out that the average of the oxygen density of the measurement gas chamber 7 and the oxygen density in an exhaust pipe are in agreement.
[0028] Thus, even if it makes high the frequency of the rectangle current energized for the oxygen-pumping component 3, the duty ratio 0.5 of a rectangle current and 450mV of generated voltages of the oxygen-concentration-cell component 5 can be made to correspond to the gasoline engine currently driven by theoretical air fuel ratio in this example.
[0029] For this reason, when [for example,] the duty ratio of the rectangle current energized for the oxygen-pumping component 3 in order to set the generated voltage of the oxygen-concentration-cell component 5 to 450mV must be

made smaller than 0.5, Namely, when the current of the negative direction which supplies oxygen to the measurement gas chamber 7 must be energized for a long time than the current of the forward direction When the duty ratio of the rectangle current energized for the oxygen-pumping component 3 in order the air-fuel ratio of a gasoline engine is rich and to set the generated voltage of the oxygen-concentration-cell component 5 to 450mV conversely must be made larger than 0.5, That is, when the current of the forward direction which discharges oxygen from the measurement gas chamber 7 must be energized for a long time than the current of the negative direction, it can be judged that the air-fuel ratio of a gasoline engine is Lean. Moreover, detection of such an air-fuel ratio can be similarly performed, even if the frequency of a rectangle current is high.

[0030] Furthermore, software can perform processing which computes an air-fuel ratio from the duty ratio of a rectangle current using an one-chip microcomputer, and detection precision can be raised while simplifying the configuration of detection equipment. Thus, with the air-fuel ratio detection equipment of this example, by detecting an internal combustion engine's air-fuel ratio based on the duty ratio of the rectangle current energized for the oxygen-pumping component 3, while simplifying the configuration of detection equipment, detection precision can be raised, and responsibility can be raised by making the frequency of the rectangle current high further.

[0031] In addition, although two kinds of current values with +200micro-[A and] 300microA constitute the rectangle current energized for the oxygen-pumping component 3 from this example, this current value can be set as a suitable value according to the property and the air-fuel ratio which it is going to detect of an air-fuel ratio sensor.

[0032]

[Effect of the Invention] Detection precision can be raised, while simplifying the configuration of detection equipment since the air-fuel ratio is detected by the air-fuel ratio detection approach of this invention based on the duty ratio of the rectangle current energized for an oxygen-pumping component as explained in full detail above.

[0033] Moreover, since the generated voltage of an oxygen-concentration-cell component does not become high even if it makes high the frequency of the rectangle current energized for an oxygen-pumping component, the frequency of a square wave can be made high and the responsibility of detection can be raised.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to the air-fuel ratio detection approach of detecting an air-fuel ratio using the oxygen sensor which generates the signal corresponding to the oxygen density under exhaust air, in various burning appliances, such as an internal combustion engine.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is an outline block diagram showing the air-fuel ratio detection equipment of an example.
[Drawing 2] It is an explanatory view showing the wave of the rectangle current of the low frequency supplied to the oxygen-pumping component of an example, and the generated voltage of an oxygen-concentration-cell component.
[Drawing 3] It is an explanatory view showing the wave of the rectangle current of the high frequency supplied to the oxygen-pumping component of an example, and the generated voltage of an oxygen-concentration-cell component.
[Drawing 4] It is an explanatory view showing the wave of the rectangle current of the low frequency supplied to the oxygen-pumping component of the conventional example, and the generated voltage of an oxygen-concentration-cell component.
[Drawing 5] It is an explanatory view showing the wave of the rectangle current of the high frequency supplied to the oxygen-pumping component of the conventional example, and the generated voltage of an oxygen-concentration-cell component.
[Description of Notations]
1 -- Air-fuel ratio sensor 3 -- Oxygen-pumping component 5 -- Oxygen-concentration-cell component
7 -- Measurement gas chamber 17 -- Gaseous diffusion limit section 19 -- Relay
21, 23, 25 -- DC power supply

[Translation done.]

* NOTICES *

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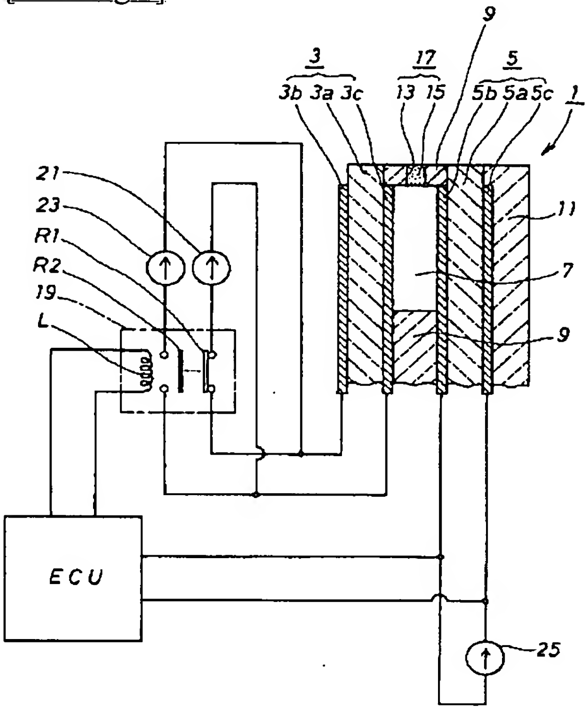
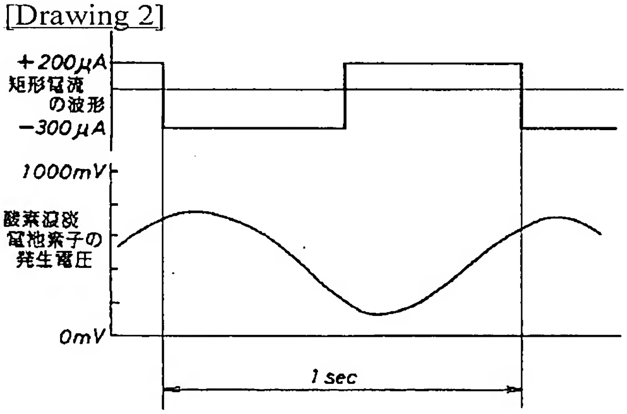
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

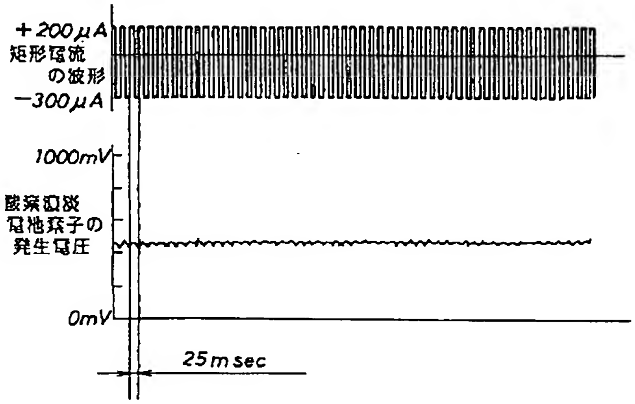
[Drawing 1]



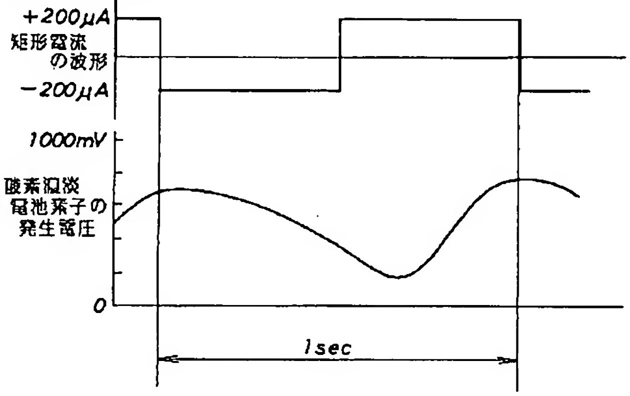
[Drawing 2]



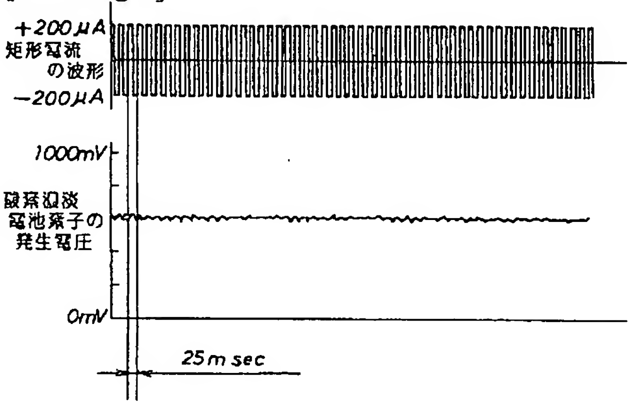
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]